CRUISE REPORT

5 December 2002

NOAA Ship DELAWARE II
Cruise No. DE 02-06
Joint Deepwater Systematics and Marine Mammal Survey

CRUISE PERIOD AND AREA

The cruise was conducted during 16 July – 2 August 2002. The area of operation was the western North Atlantic Ocean in the vicinity of Bear Seamount, located at approximately 39^{o} 55' North latitude, 067^{o} 25' West longitude, and along the continental slope south of George's Bank. Figure 1 shows the area of operations and trawling station locations.

OBJECTIVES

The cruise objectives were twofold: (1) to explore the biodiversity in the vicinity of Bear Seamount and to collect nekton (especially fish and cephalopod) specimens in bottom and midwater samples from the maximum depths possible and (2) to collect information on the distributional relationship between cetaceans, particularly beaked whales and sperm whales, oceanographic features, and potential prey.

The nekton collections included tissue samples, photographs of freshly collected specimens and systematic characters, and voucher specimens for deposition in museum collections at the National Museum of Natural History (NMNH), Smithsonian Institution, the Museum of Comparative Zoology (MCZ), Harvard University and the Peabody Museum, Yale University (YPM). Ancillary objectives included collection of specimens and tissues from other groups of animals and observations on the distributions of turtles and seabirds.

METHODS

Vessel operations were conducted 24 hours per day. Two trawling watches and one marine mammal watch were established. All scientific watch schedules were 12 hours-on and 12 hours-off.

Trawling was conducted using two gear types: an IGYPT midwater trawl and a Yankee 36 bottom trawl. NEFSC standard polyvalent trawl doors were used for bottom and midwater doors were used with the IGYPT trawl. The trawling targeted depths ranging from 400-2000 m. The ship maintained a relatively high speed (ca. 5 kts) while the trawl wire was being paid out so that pressure on the doors would be sufficient to keep them from collapsing together. Once the trawl was set, ship speed was immediately reduced to 1.5-2.5 kts. Both bottom and midwater trawls were towed for one hour at target depth. Trawl mesh was checked carefully for entangled animals upon retrieval. Trawl samples were immediately sorted to major taxonomic groups, then all fishes and cephalopods were identified, counted, and measured, and tissue samples collected.

Samples of other animals (e.g., sponges, cnidarians, crustaceans, mollusks) were also collected. A recording CTD was rigged to the headrope of the IGYPT net, providing hydrographic data concurrent with the trawls, as well as depth of the tow (Appendix I).

Because this was a joint operation, marine mammal surveying was conducted under two modes (i.e., primary and secondary). During primary mode (18 - 23; 30-31 July, and 1 August), surveying was conducted along predetermined transect lines (Appendix II, Figure 1). During secondary mode (24-29 July) surveying was conducted in association with daytime trawling near Bear Seamount, and "transect lines" were not predefined. Sea surface temperature, bathymetric, CTD , bongo, and midwater trawl data were collected in association with primary-mode surveying. Further details of survey methodology are presented in Appendix II.

RESULTS

Accomplishments.

Trawling:

Deep midwater trawling with the double-warp gear was very successful. In all, 20 stations were sampled with the IGYPT midwater trawl (Appendix I, Table 1). All tows planned in the vicinity of Bear Seamount were accomplished. Additionally, sets of midwater samples were successfully collected in three slope/canyon areas where aggregations of toothed whales were encountered. Only three bottom trawls were completed on Bear Seamount before the gear hung on the bottom and was lost.

Preliminary identifications indicate that about 183 species of fishes, at least 33 species of cephalopods, and 152 types of other invertebrates were collected from on or over Bear Seamount during this cruise (Appendix I, Table 2). A more precise list will be produced once taxonomic experts have had an opportunity to complete their studies of the animals captured.

Marine mammal observations:

Approximately 435 nautical miles of trackline were surveyed, focusing on the 1000 m isobath. Eleven species of mammals and two of turtles were observed during the cruise (Appendix II, Table 2m). Geographic distribution of sightings is presented in a series of figures in Appendix II. Sightings were concentrated in slope areas, generally associated with canyons and hydrographic fronts, rather than around Bear Seamount. Analysis of seabird sightings has not yet been completed. We also plan to analyze concordance of fauna collected by the midwater trawl with the distribution of marine mammals.

Physical oceanography:

Complete physical oceanographic results are presently available through ftp site ftp://ftp.wh.whoi.edu/pub/hydro/del0206/DEL0206_ctd.html.
Contents of the site, along with a brief background presentation, are listed in the

introductory page, which is copied in Appendix III.

Problems encountered.

Sampling problems:

1. Insecure cod-end on the IGYPT – resolved after the first several tows.
2. Failure of the Seabird CTD – discussed below in Appendix III.
3. Download problems with the headrope CTD - discussed below in Appendix III.
4. ITI net-monitoring system would not work with the net as far down and back from the ship as we were towing – unresolved.
5. Some difficulties were encountered in trying to plan long, deepwater tows in the vicinity of whale aggregations because the whales were aggregated in the same areas that swordfishermen were setting longlines – this required alteration of tow paths and constant coordination between the ship's watch officers and nearby fishing boats.
6. Loss of the bottom trawl; having no backup gear, we had to stop bottom trawling at that point. Even the few successful bottom tows were characterized by net damage and improper fishing.

Ship and logistical problems:

1. Overheating of the engine room due to an exhaust leak – required return to port plus a day in port to repair.
2. Late arrival of ordered deep-water trawl floats – resolvcd with the aid of the U.S. Coast Guard, who delivered the floats off Chatham, MA so that we would not have to return to Woods Hole. The planned order of the mammal and trawling components was reversed to accommodate the late arrival.
3. Lack of requested permit to enter Canadian waters – survey trackline for mammal component was modified to remain in US waters.
4. Problems with e-mail – resolved after a couple of days.
5. Some confusion about what blocks, tackle, etc. were required for all of the various sampling gear.
6. Some confusion about responsibilities for rigging gear and changing floats on nets – this and the previous item are coordination problems that the Chief Scientist will endeavor to avoid in the future.

Recommendations.

The most poorly sampled fauna of the western North Atlantic is found at depths >1000 m. Seamounts, in particular, hold great promise for undiscovered biodiversity and require sampling at depths >1000 m. Both midwater and bottom trawling, preferably with large nets which require double warp towing, should be conducted at depths between 1000-5000 m. In particular, deep bottom trawling should focus on the most difficult terrain, the seamounts and deep areas of canyons. This means increased likelihood of gear damage and loss. However, the fauna of such steep, deep bottoms is practically unknown. Deep-sea fishery resources are being exploited in such areas elsewhere in the world. It makes sense to explore and study deepwater habitats and the distribution and biology of such animals before large-scale exploitation begins in the western North Atlantic. Although damage and loss of gear are almost unavoidable in such research, future bottom trawling around Bear Seamount should avoid the especially rough terrain of the southeast corner of the seamount, where the bottom trawl was lost on this cruise.

DISPOSITION OF SAMPLES AND DATA

Fishes. The majority of the fish specimens retained have been deposited in MCZ, with the rest divided between NMNH and YPM. Most of the fish tissue samples were sent to Dr. Ed Wiley of the Museum of Natural History, University of Kansas.

Cephalopods. Most of the cephalopods collected were retained and are at NMNH. Cephalopod tissue for DNA analysis has been retained at NMNH until analyses can be arranged through Dr. David Carlini of American University.

Other invertebrates. Representative decapod crustaceans were collected for Dr. Martha Nizinsky of NSL. Holoplanktonic mollusks were fixed for DNA analysis for Dr. Jerry Harasewych of NMNH. Benthic cnidarians went to Dr. Stephen Cairns of NMNH. Dr. David Pawson of NMNH received the echinoderms. Other invertebrates have been transferred to YPM.

Data. Standard NEFSC logs were completed for each station. A copy of these sheets will be kept at NMNH and the originals returned to Survey Branch, FEMAD. All original CTD data have been transferred to Oceanography Branch, NEFSC.

SCIENTIFIC PERSONNEL:

Name	Title	Organization
Michael Vecchione	Chief Scientist	NMFS, NEFSC, NSL, Washington, DC
Gordon Waring	MMPI	NMFS, NEFSC, PSB, Woods Hole, MA
Sara Henley	Contract Technician	NMFS, NEFSC, NSL, Washington, DC
John Nicolas	Mar. Mammal Spec.	NMFS, NEFSC, PSB, Woods Hole, MA
Frederick Wenzel	Fish. Biologist	NMFS, NEFSC, PSB, Woods Hole, MA
Gina Reppucci	Fish. Biologist	NMFS, NEFSC, PSB, Woods Hole, MA
Marjorie Rossman	Fish. Biologist	NMFS, NEFSC, PSB, Woods Hole, MA
Peter Chase	Fish. Biologist	NMFS, NEFSC, SB, Woods Hole, MA
Jon Moore	Faculty	Fla. Atlantic Univ., Jupiter, FL
Christopher Kenaley	Technician	Harvard Univ., MCZ, Cambridge, MA
Tracey Sutton	Post-Doctoral Fellow	WHOI, Woods Hole, MA
Ruth Gibbons	Museum Specialist	NMFS, NEFSC, NSL, Washington, DC
Edward McChain	Volunteer	

NSL = National Systematics Laboratory
MMPI = Marine Mammal Principal Investigator
PSB = Protected Species Branch

SB = Survey Branch
MCZ = Museum of Comparative Zoology
WHOI = Woods Hole Oceanographic Institution

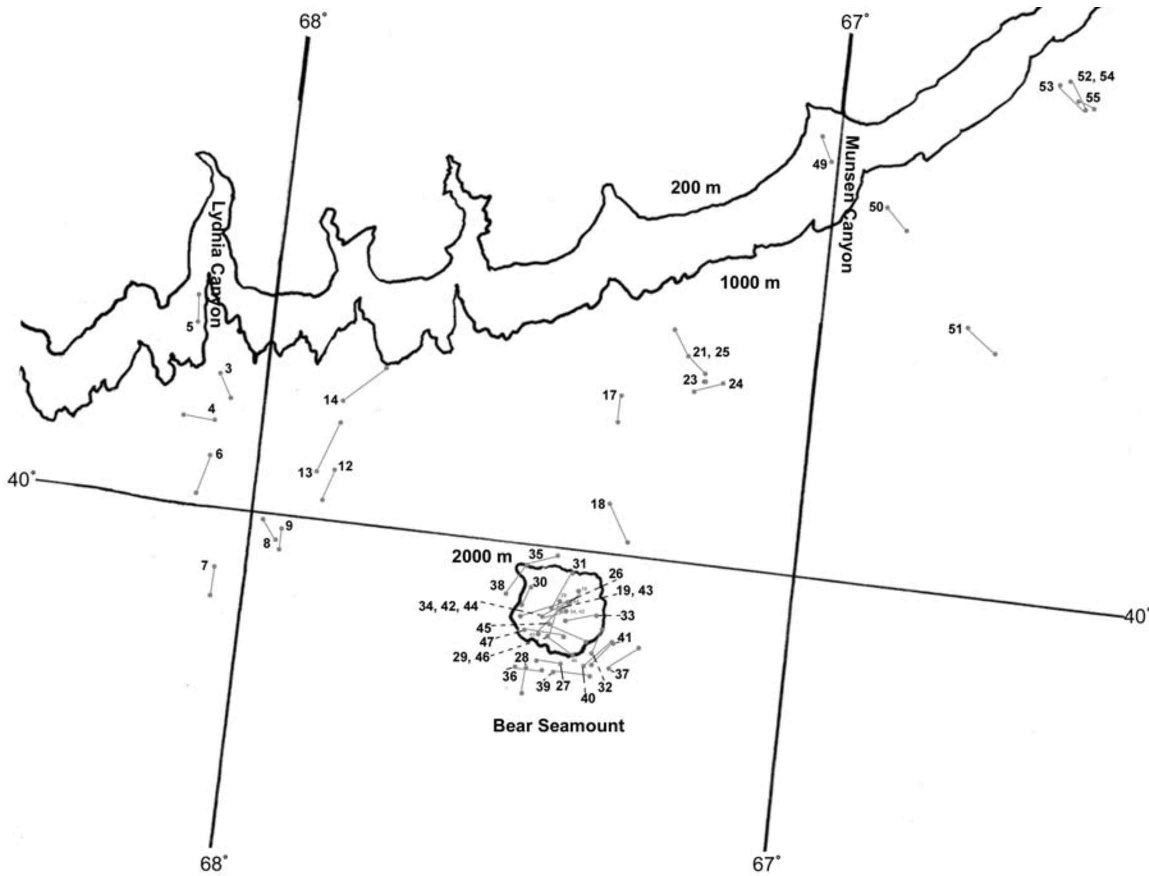

Figure 1. General study area, showing location of Bear Seamount and trawl station locations.

Appendix I. Paper presented at ICES 2002 Annual Science Conference summarizing the results of DE02-06.

CM 2002/M:25

The fauna of Bear Seamount (New England Seamount chain), and the presence of "natural invader" species

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Abstract

Bear Seamount (39° 55'N 67° 30'W) is an extinct undersea volcano rising up from the continental slope of Georges Bank. This seamount is the westernmost peak in the New England Seamount (NES) chain. The fauna associated with this seamount was little known until twenty trawl stations were made in late 2000 by the NOAA ship DELAWARE II. That cruise resulted in a faunal list of over 300 species of invertebrates and fishes. A follow-up cruise in July 2002 has added to our knowledge of overall species diversity. Although some of the captured species are still being identified, we present preliminary identifications and results from that latest cruise. One interesting result from the faunal studies, so far, is the recognition that a small percentage of the fauna is represented by "natural invader" species. Most of these species are more typically found in the eastern Atlantic, and are either rare or previously unknown from the western Atlantic. In addition, a few other eastern Atlantic species are also found on the slope of Georges Bank in close proximity to Bear Seamount. These species appear to represent essentially non-anthropogenic invasion, a natural biogeographic process. How these species arrived at or in the vicinity of Bear Seamount is unknown at this time, however, it is possible that the NES chain is acting as a dispersal corridor or "stepping stones" as envisioned by Hubbs in 1959.

Keywords: deep sea, fauna, seamount, North Atlantic, biogeography

Introduction

The New England Seamounts

The New England Seamounts make up the longest seamount chain in the North Atlantic, encompassing more than 30 major extinct volcanic peaks extending from Georges Bank southeast for about 1100 km and ending abruptly with Nashville Seamount to the ENE of Bermuda. The major peaks of the New England Seamounts rise as much as 4000 m above the floor of the Sohm Abyssal Plain. About 300 km east of Nashville Seamount, the Corner Rise Seamounts form a cluster of peaks midway between the eastern end of the New England Seamounts and the Mid Atlantic Ridge. The New England Seamounts and the Corner Rise Seamounts resulted from a mantle-plume hotspot, which has migrated eastward under the Mid Atlantic Ridge and now resides underneath Great Meteor Seamount (Sleep, 1990).

The New England Seamount chain lies roughly perpendicular to major currents, the Gulf Stream flowing to the northeast and the Deep Western Boundary Current flowing southwesterly along the continental slope. These seamounts alter the flow of the currents in their vicinity (Hogg et al., 1986; Ezer, 1994), which may influence the recruitment of benthic and pelagic organisms.

Bear Seamount is the westernmost peak in the New England Seamount chain rising up from the continental slope southeast of Lydonia Canyon on Georges Bank (Moore et al., 2001). Bear rises from a depth of 2000-3000 m to a generally flat summit around 1002 m below the sea surface. Because Bear Seamount rises out of the continental slope, it projects into the Deep Western Boundary Current, a cold-water current flowing from the Labrador Sea. This means that the fauna found associated with Bear Seamount may be somewhat unrepresentative of the chain, because it is experiencing colder water conditions than many of the other New England Seamounts.

<u>The seamount fauna</u>

Until recently, the fauna associated with the New England Seamounts was virtually unknown and the entire chain was not considered in a review of seamount faunas worldwide (Rogers, 1994). Commercial fishers, however, have considered the seamounts as potential sites for fishery resources, such as orange roughy, and proposed exploratory fishing of these seamounts. Recognizing the lack of information on the New England Seamount fauna, the US National Marine Fisheries Service (NMFS) conducted an initial research survey of Bear Seamount in 2000. Preliminary identifications of the fauna from 20 trawls on and over Bear Seamount resulted in the capture of 115 fish species and at least 159 invertebrate species during a single short cruise (Moore et al., 2001). These results indicated that the fauna associated with Bear Seamount is highly diverse and implies that the other New England Seamounts may also harbor a high diversity of macro-organisms. A follow-up cruise was scheduled for 2002 to continue studies of the fauna found around Bear Seamount and we report here the preliminary results of that second cruise.

Several species previously collected from Bear Seamount have disjunct distributions and provided evidence for long-distance dispersal. One objective of the second cruise was to further investigate the biodiversity and biogeography of the deepwater animals associated with Bear Seamount.

Materials and Methods

Twenty-four hauls were made on or over Bear Seamount using double-warp gear towed from the NOAA vessel R/V Delaware II from 21-29 July 2002 during cruise DE02-06 (see Table 1 for a list of stations). Of these hauls, 21 were fully pelagic tows and 3 were bottom trawls. Each tow was for one hour once the net was set at depth. The pelagic tows were made with an IYGPT midwater net set at 362-1475 m depth and the bottom tows were made with a standard NMFS Yankee 36 otter trawl at depths of 1119-1489 m depth. A CTD attached to the headrope of the net provided temperature, salinity and depth data for the path of the net.

The differing biases and catch abilities of these two nets make explicit calculations of diversity indices suspect. The numbers of individuals are noted for each species to give a qualitative sense of the relative abundances. However, some very abundant species (e.g., light brown jellyfish, salps, *Cyclothone*, *Acanthephyra*) had many individuals caught in the wings of the net and it was prohibitively time consuming to collect common species from the wings, so these species have counts lower than what was actually caught. These species have a + after the number of individuals to show the underestimate of actual specimens caught.

Catches were sorted and given preliminary identifications on shipboard. Tissue samples of fishes, molluscs, corals and crustaceans were taken for DNA analysis (samples of fishes are deposited at the Museum of Natural History, University of Kansas; the invertebrate samples were distributed to various investigators). Representative specimens of most species were preserved as vouchers. The voucher specimens are deposited in the Museum of Comparative Zoology at Harvard University (most fish specimens), Peabody Museum of Natural History at Yale University (some fishes and many invertebrates), and the National Museum of Natural History, Smithsonian Institution (many invertebrates). Many specimens were sent to taxonomic experts for subsequent definitive identifications. These experts have not yet finished their identifications, due to the short time since the cruise. This report will focus on the fishes captured, due to the better taxonomic understanding of this group and the extensive distributional information available. Explicit information on deepwater fish distributions in the region extending between 38°N (roughly in line with the Maryland/Virginia border) and 63°W (in line with the Scotian Shelf in the vicinity of Emerald Bank) is found in Moore et al. (ms).

AVHRR satellite images (available at Johns Hopkins University's Applied Physics Laboratory - http://fermi.jhuapl.edu/avhrr/) and a shipboard CTD provided information on sea surface temperatures. A CTD on the net was used to identify temperature at depth during the trawls.

Results

The sea surface temperature satellite images indicated a loop of the Gulf Stream was about 75 miles east of Bear Seamount and flowing northwards into close proximity of Georges Bank at the time of our sampling. Plumes of warm water could be seen peeling off the Gulf Stream and extending westward over the New England Seamounts. Sea surface temps were as high as 28°C within the Gulf Stream and 24°C over Bear Seamount. Temperatures of 15°C at 200 m are used to define the northern or shoreward edge of the Gulf Stream (Haedrich, 1972). Temperatures at 200 m depth were between 10 to 11°C over Bear Seamount and between 3 to 4°C at 1100 m depth at the top of Bear Seamount.

Table 1 provides a preliminary list of fish and invertebrate species collected within 10 km of Bear Seamount during cruise DE02-06 and identified to date. Several fish records are new for the New England area (Moore et al., ms), including *Heterophotus opisthoma*, *Ahliesaurus berryi*, *Stylephorus chordata*, *Brotulotaenia crassa*, and *Kali indica*. We report a total of at least 183 species of fishes and 152 invertebrates collected from on or over Bear Seamount during this cruise. Bear in mind that this is a very preliminary list of taxa and most likely underestimates the true diversity – most of our taxonomic experts have not had time to definitively identify the animals captured, especially the invertebrates. A more precise list will be produced once they have had an opportunity to complete their studies of the animals captured around Bear Seamount.

Discussion

New populations of species can become established at great distances from original source population (Nathan et al., 2002). The two extreme examples of how this can occur are single event colonization over a great distance (= long-distance dispersal) or gradual expansion by small steps. Single-steps are rare, inherently unlikely, and therefore unpredictable. Such dispersal events should be thought of as unique events requiring special explanations. Gradual range expansions should follow likely corridors and can be more common.

Some of the deepwater species found associated with Bear Seamount (and also, in a few cases, with the immediately adjacent Georges Bank slope) have unusual distributions that point towards long-distance dispersal mechanisms. At least 17 species of fishes exhibit distinctly disjunct distributions of at least 1500 km from the nearest known occurrence (Table 2). These species have presumably extended their distributional ranges through natural mechanisms (to our knowledge, no anthropogenically mediated invasions have occurred among deepwater species). Natural long-distance dispersal events that lead to establishment of disjunct populations are considered by some as cases of invasive species (see ESA, 2002), but have been disregarded in other cases (Ruiz et al. 2000). Here we refer to the disjunct populations as ‘natural invaders’.

We can envision three routes for these natural invaders into the vicinity of Bear Seamount. For those species normally found in the deep waters of the Caribbean and Gulf of Mexico regions, the Gulf Stream, and warm-core eddies that spin off from the Gulf Stream, is the obvious mechanism (Markle et al., 1980; Harold and Clark, 1990). This is supported by the fact that most of the species with disjunct distributions from that region are meso- to bathypelagic species capable of spending long transport times in midwaters. Further evidence for this route comes from the most recent cruise. A loop of the Gulf Stream was in the immediate vicinity of Bear Seamount and almost all of the new additions of fishes to the faunal list were typically tropical to subtropical species.

A second route is via the Deep Western Boundary Current (DWBC) flowing southwest from the Labrador Sea (Hamilton et al., 1996). This cold-water current flows along the continental slope and can potentially transport boreal species southwards to Bear Seamount. Water temperatures at depths of 1000-1400 m around Bear Seamount were in the range of 3.6-4.2^{o}C, which is typical for DWBC. Four species (*Apristurus microps*, *Normichthys operosus*, *Gaidropsarus argentatus* and *Bathypterois dubius*) are known from the Grand Banks and Bear Seamount, but not elsewhere between despite extensive trawling in Canadian deep waters. It should be noted, however, that *Apristurus microps, Normichthys operosus* and *Bathypterois dubius* are very rarely found on the slope of the Grand Banks, but these species are much more common in the eastern Atlantic.

The third route is from the eastern Atlantic Ocean via a series of seamount ‘stepping stones’ as envisioned by Hubbs (1959). Several species of fishes (*Hydrolagus* *pallidus*, *Coryphaenoides guentheri* and *Epigonus telescopus*) are typically found in the eastern Atlantic, but may have dispersed into the vicinity of Bear Seamount via the Mid Atlantic Ridge to the Corner Rise Seamounts to the New England Seamounts and on up the chain to Bear Seamount. The nearest known occurrences of *Epigouns telescopus* and *Brotulotaenia crassa* are in fact the Corner Rise Seamounts (Vinnichenko 1997). This third route is a possible alternative dispersal corridor for the *Normichthys operosus*, *Bathypterois dubius* and *Apristurus microps*. In addition, this route could also possibly explain the anomalous distribution of the cutthroat eel (*Diastobranchus capensis*), which previously was known from South Africa, Australia and New Zealand, but is now known from Bear Seamount and canyons on the continental slope (Moore et al., ms and 2001).

Population genetic studies could help understand these dispersal events (Nathan et al., 2002). Single step long-distance dispersal events, resulting in the establishment of a new population of what initially would be a very few individuals, may cause an extreme form of genetic drift. For gradual range extensions, the population genetics could include some effects of drift, but should be less so, because of larger population sizes at intermediate steps. Local extinction and recolonization is another way to maintain an expatriate population in an area at the extreme edge of physiological or ecological tolerances. The population genetics of such would be very similar to source population because of frequent reestablishment from the source.

Our list of disjunct distributions may underestimate the actual number of such distributions, since we were only considering those species with 1500 km gaps or larger in their known occurrences. In addition, we have not considered the invertebrate fauna. However, there do appear to be some interesting disjunct distributions among those taxa as well (e.g., the seastar *Porcellanaster ceruleus* and solitary coral *Caryophyllia ambrosia ambrosia* are known from the New England continental slope and widely in the East Atlantic and the isopod *Syscenus atlantica* is known from Bear Seamount and the Reykjanes Ridge). Further information on the invertebrates and future studies on the faunas from other New England Seamounts may eventually provide more evidence for the stepping stone dispersal corridor between the eastern Atlantic and New England region.

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Table 1. List of stations in the vicinity of Bear Seamount from cruise DE02-06. For those stations where the CTD was not in use, maximum depth is estimate from meters of wire out.

DELAWARE II DE02-06 STATIONS AT BEAR SEAMOUNT							
Station	**Date**	**Gear**	**Time**	**Starting Lat & Long**	**Ending Lat & Long**	**Max. Depth (m)**	**Range ºC during 60 min. tow (Surface Temp.)**
18	7/21/02	IGYPT	2339	40° 04' N 67° 19' W	40° 01' N 67° 18' W	1475	21.6 – 22.9
19	7/22/02	IGYPT	0339	39° 55' N 67° 25' W	39° 57' N 67° 23' W	419	23 – 23.2
26	7/25/02	IGYPT	0244	39° 56' N 67° 24' W	39° 54' N 67° 29' W	418	22.8 – 23.3
27	7/25/02	IGYPT	0545	39° 51' N 67° 24' W	39° 51' N 67° 27' W	485	23.2 – 23.4
28	7/25/02	IGYPT	0931	39° 50' N 67° 28' W	39° 47' N 67° 28' W	1152	23.4 – 23.6
29	7/25/02	IGYPT	1329	39° 53' N 67° 26' W	39° 56' N 67° 25' W	~440	23.6 – 24.3
30	7/25/02	IGYPT	1724	39° 57' N 67° 28' W	39° 55' N 67° 29' W	1194	23.5 – 23.8
31	7/25/02	IGYPT	2153	39° 58' N 67° 24' W	39° 55' N 67° 26' W	~660	23.4 – 23.7
32	7/26/02	IGYPT	0209	39° 52' N 67° 21' W	39° 54' N 67° 20' W	~1320	23.4 – 23.9
33	7/26/02	IGYPT	0638	39° 55' N 67° 21' W	39° 54' N 67° 24' W	~1100	23.7 – 24
34	7/26/02	IGYPT	0953	39° 54' N 67° 27' W	39° 56' N 67° 24' W	~440	23.3 – 23.6
35	7/26/02	IGYPT	1923	39° 59' N 67° 26' W	39° 58' N 67° 29' W	1160	23.9 – 24.2
36	7/26/02	IGYPT	2340	39° 50' N 67° 29' W	39° 50' N 67° 26' W	362	23.4 – 23.6
37	7/27/02	IGYPT	0318	39° 51' N 67° 19' W	39° 53' N 67° 16' W	1413	24.1 – 24.3
38	7/27/02	IGYPT	0905	39° 56' N 67° 31' W	39° 58' N 67° 29' W	972	23.9 – 24.2
39	7/27/02	IGYPT	1345	39° 50' N 67° 25' W	39° 50' N 67° 21' W	~1100	23.2 – 23.4
40	7/27/02	IGYPT	1909	39° 51' N 67° 22' W	39° 53' N 67° 19' W	~1320	24.5 – 24.7
41	7/27/02	IGYPT	2250	39° 53' N 67° 19' W	39° 51' N 67° 21' W	~440	24.2 – 24.5
42	7/28/02	IGYPT	0148	39° 54' N 67° 27' W	39° 55' N 67° 24' W	~440	23.9 – 24
43	7/28/02	IGYPT	0440	39° 55' N 67° 25' W	39° 53' N 67° 27' W	~660	23.9 – 24 .4
44	7/28/02	YANKEE 36	2121	39° 54' N 67° 27' W	39° 56' N 67° 24' W	~1232	19.9 – 21.2
45	7/29/02	YANKEE 36	0226	39° 53' N 67° 26' W	39° 53' N 67° 22' W	1377	24.2 – 24.3
46	7/29/02	YANKEE 36	0801	39° 53' N 67° 26' W	39° 52' N 67° 23' W	1489	23.8 – 23.9
47	7/29/02	YANKEE 36	1642	39° 53' N 67° 28' W	39° 53' N 67° 24' W	~1760	20.9 – 22.6

Table 2. Preliminary list of taxa collected on or from waters around Bear Seamount during cruise DE02-06. Pelagic taxa were from stations within 10 km of Bear Seamount.

PORIFERA	
Demospongae? fragments	**1**
Hexactinellid sponge	**7**
***Geodia* sp.**	**1**
Encrusting sponge	**1**
CNIDARIA	
***Atolla* sp.**	**26**
Jellyfish - yellowish brown	**54+**
Jellyfish - unid.	**2**
Pelagia noctiluca	**17+**
***Periphylla* sp.**	**1**
***Stigiomedusa* sp.**	**1**
Siphonophore - colony stem	**1**
Orange siphonophore root = *Marrus?*	**2**
Black siphonophore root	**1**
Anemone	**1**
Anemone – dark brown	**3**
Anemone - orange tentacles	**3**
Epizoanthus paguriphilus	**3**
Caryophyllia ambrosia	**1**
Flabellum alabastrum	**3**
***Paragorgia* sp. fragment**	**1**
Gorgonian (Coral 2)	**1**
Gorgonian (Coral 4)	**1**
***Keratoisis* (Coral 1)**	**2**
***Swiftia*? (Coral 3)**	**1**
***Lepidisis* sp. (skeleton)**	**1**
Gorgonian – plumose	**1**
Pennatulaceans	**6**
PLATYHELMINTHES	
Pink Flatworm	**2**
Jelly-like worm	**1**
ANNELIDA	
Serpulid worm tubes	**5+**
SIPUNCULIDA	
Elongate sipunculid	**1**
Golfingia	**5**
MOLLUSCA	
Heteropods	**10+**
***Pterotrachaeio* sp.**	**6**
pteropod sp. 1	**1**
pteropod sp. 2	**1**
pteropod sp. 3	**1**
pteropod sp. 4	**3**
***Cavalina* sp.**	**3**
***Clio* sp.**	**1**
Corolla spectabilis	**14+**
Bivalve	**2**
Unidentified gastropods	**5**
***Scaphander?* - bubble shell**	**1**
CEPHALOPODS	
Abralia redfieldi	**1**
***Abraliopsis* sp.**	**1**
Abraliopsis hoylei pfefferi	**17**
Enoploteuthis leptura	**2**
Pyroteuthis margaritifera	**3**
Pterygioteuthis gemmata	**8**
Pterygioteuthis gemmata?	**1**
Ancistrocheirus lesueurii	**3**
Octopoteuthis sicula	**20**
Octopoteuthis sicula?	**1**
Octopoteuthis megaptera	**2**
Ancistroteuthis?	**1**
Onychoteuthis banksii	**1**
Onychoteuthis cf. banksii	**1**
Discoteuthis laciniosa	**2**
Gonatus fabricii	**1**
Histioteuthis corona	**5**
Histioteuthis corona ?	**1**
Histioteuthis reversa	**47**
***Brachioteuthis* sp.**	**4**
Illex illecebrosus	**10**
Ornithoteuthis antillarum	**5**
***Chiroteuthis* sp.**	**2**
Chiroteuthis mega	**8**
Chiroteuthis veranyi	**3**
Chiroteuthis veranyi?	**1**
***Mastigoteuthis* sp.**	**4**
Mastigoteuthis agassizi	**22**

Mastigoteuthis agassizi?	8
Mastigoteuthis hjorti	2
Mastigoteuthis magna	38
Mastigoteuthis magna?	4
Cranchiidae	1
Cranchiidae – head	1
Cranchia scabra	2
Helicocranchia pfefferi	2
Megalocranchia sp.	5
Leachia sp.	1
Leachia atlantica?	1
Taonius pavo	8
Teuthowenia megalops	7
Unidentified squid	2
Unidentifed squid head	3
Bolitaena pygmaea	2
Japetella diaphana	1
Haliphron atlanticus	9
Tremoctopus violaceaus?	1
Vampyroteuthis infernalis	12

ARTHROPODA

Small white pycnogonid	1
Colossendeis colossea	11
Unid. Crustaceans	9
Amphipod	9
Large red amphipod	20
Small red amphipod	3
Small dark amphipod	1
Tan amphipod	3
Cystisoma sp.	24
Phronima sp.	826+
Phrosima sp.	33
Thermisto sp.	15
Anuropus n. sp.	2
Isopod	1
Syscenus atlanticus	10
Gigantocypris sp. (ostracod)	1
Scalpellum sp. barnacle	7
Aristeidae	1
Acanthephyra sp.	27
Acanthephyra sp. #2	50
Acanthephrya cartirostris	1
Acanthephyra purpurea	449+
Benthesicymus bartletti	7
Funchalia sp.	2
Funchalia villosa	7
Gennadas sp.	12
Janecella sp.	44
Janecella gracilorostris	1
Notostomus sp.	7
Notostomus vescus	1
Pandalus sp.	1
Parapandalus richardi	2
Pasiphaea sp.	1
Parapasiphaea sp.	2
Parapasiphaea sulcatifrons	30
Sergia sp.	125
Sergestidae	1
Sergestes sp.	137
Unidentified shrimp	12
Euphausids	18
Bentheuphausia amblyops	1
Decapod sp.1	1
Crab megalops	3
Chaceon quinquidens	1
Heterocarpus-like	1
Hermit crab	1
Majid crab	2
Lithodid	1
Neolithodes grimaldii	1
Parapagurus pilosimanus	3
Polychelid	4
Polycheles granulatus	3
Steromastis nana	1
Munidopsis curvirostra	1
Mysids	
Gnathophausia sp.	28
Ganthophausia ingens	10

ECHINODERMATA

crinoid calyx	3
Holothuroid	1
Plutonaster agassizi	4
Cheiraster sp.	22
Cheiraster sepitus	2
Floriaster-like sea star	1
Hippasteria phrygiana	1
Mediaster bairdi	2
Neomorphaster forcipatus	31
Chondraster grandis	1
Brisingid	1
Ophiuroid sp. 1	18
Ophiuroid sp. 2	7

Ophiuroid sp. 3	15
Ophiomusim lymani	109
Ophiacantha sp.	14
Simple basket star	2
Echinus affinis	12
Phorosoma sp.	12

UROCHORDATA

Pyrosoma sp.	84
Pyrosoma sp. 2	1
Thetys vagina	3
Unid. Colonial salp	1
Salps	9
Salpa sp. 1	13
Salpa sp. 2	4

FISHES

Hydrolagus affinis	2
Apristurus manis	4
Apristurus profundorum	4
Etmopterus gracilispinous	1
Aldrovandia affinis	8
Aldrovandia phalacra	9
Notocanthus chemnitzii	1
Diastobranchus capensis	4
Synaphobranchus kaupi	42
Derichthys serpentinus	12
Leptocephalus	9
Nessorhamphus ingolfianus	17
Avocettina infans	1
Nemichthys scolopaceus	86
Serrivomer sp. (dark)	6
Serrivomer beanii	294
Saccopharynx ampullaceus	1
Eurypharynx pelacanoides	86
Bathylagidae	1
Bathylagus sp.	7
Bathylagus euryops	39
Dolicholagus longirostris	61
Melanolagus bericoides	3
Alepocephalus sp.	17
Alepocephalus bairdii	1
Photostylus pycnopterus	1
Normichthys operosus	4
Bonapartia pedaliota	2
Cyclothone sp.	123+
Cyclothone braueri	7
Cyclothone microdon	77+
Sigmops bathyphilum	3
Sigmops elongatum	735
Maurolicus weitzmani	*1*
Argyropelecus sp.	3
Argyropelecus aculeatus	252
Argyropelecus affinis	1
Argyropelecus sp. B	2
Argyropelecus gigas	1
Argyropelecus hemigymnus	45
Argyropelecus lynchus	1
Polyipnus sp.	1
Polyipnus clarus	1
Sternoptyx diaphana	173
Sternoptyx pseudobscura	2
Vinciguerria sp.	1
Vinciguerria nimbaria	10
Chauliodus sp.	1
Chauliodus sloani	379
Stomias boa ferox	29
Borostomias sp.	1
Borostomias antarcticus	5
Bathophilus longipinnis	1
Heterophotus ophistoma	1
Chirostomias pliopterus	1
Echiostoma barbatum	1
Eustomias sp.	2
Eustomias obscurus	2
Eustomias schmidti	1
Flagellostomias boureei	1
Grammatostomias dentatus	2
Leptostomias sp.	2
Melanostomias sp.	1
Melanostomias bartonbeani	2
Photonectes sp.	4
Malacosteus niger	42
Photostomias sp.	2
Photostomias guernei	45
Idiacanthus fasciola	1

Gigantura indica	**1**
***Chlorophthalmus* sp.**	**3**
Chlorophthalmus agassizi	**1**
Bathypterois phenax	**4**
Scopelarchus guentheri	**1**
Scopelosaurus mauli	**8**
Ahliesaurus berryi	**3**
Arctozenus rissoi	**10**
***Lestidiops* sp.**	**2**
***Lestidium* sp.**	**2**
Lestrolepis intermedia	**1**
Magnisudis atlantica	**2**
***Sudis* sp.**	**1**
***Coccorella* sp.**	**2**
Coccorella atlantica	**2**
***Evermannella* sp.**	**1**
Omosudis lowei	**3**
Myctophidae	**210**
***Benthosema* sp.**	**1**
Benthosema glaciale	**4**
Bolinichthys photothorax	**1**
***Ceratoscopelus* sp.**	**1**
Ceratoscopelus maderensis	**55**
Ceratoscopelus warmingi	**285**
***Diaphus* sp.**	**6**
***Diaphus* sp. 1**	**3**
Diaphus dumerili	**112**
Diaphus lucidus	**2**
Diaphus perspicillatus	**2**
Diaphus rafinesquii	**1**
Diaphus splendidus	**2**
Gonichthys cocco	**3**
***Hygophum* sp.**	**1**
Hygophum hygomii	**391**
Lampadena luminosa	**1**
Lampadena urophos atlantica	**1**
***Lampanyctus* sp.**	**22**
Lampanyctus cuprarius	**2**
Lepidophanes guentheri	**174**
Lobianchia gemellari	**1**
Myctophum affine	**4**
Myctophum selenops	**1**
***Nannobrachium* sp.**	**5**
Nannobrachium lineatum	**7**
***Notoscopelus* sp.**	**1**
Notoscopelus caudispinosus	**4+**
Notoscopelus resplendens	**61**
***Symbolophorus* sp.**	**1**
Symbolophorus veranyi	**1**
Taaningichthys bathyphilus	**1**
Zu cristatus	**1**
Regalecus glesne	**1**
Stylephorus chordatus	**2**
Polymixia lowei	**6**
Ophidioid - dark w/spine	**1**
Brotulotaenia **sp.**	**1**
Brotulotaenia crassa	**1**
Ophidiidae - sp. 1	**2**
Ophidiidae - sp. 2	**1**
Parabrotula plagiophthalmus	**1**
Bathygadus favosus	**1**
Coryphaenoides rupestris	**38**
Macrourus berglax	**5**
Nezumia longibarbata	**1**
Sphagemacrurus grenadae	**2**
Trachonurus sulcatus	**1**
Ventrifossa macropogon?	**13**
Antimora rostrata	**5**
Halargyreus johnsonii	**5**
***Laemonema* sp.**	**4**
Melanonus zugmayeri	**3**
***Bregmaceros* sp.**	**4**
***Chaunax* sp.**	**1**
Ceratioid	**3**
Spinophryne gladisfenae	**1**
***Melanocetes* sp.**	**1**
Melanocetes johnsoni	*2*
Himantolophus albinares	**1**
Oneirodidae	**4**
***Ceratias* sp.**	**2**
***Ceratias / Cryptopsaras* sp.**	**1**
Cryptopsaras couesii	**5**
***Gigantactis* sp.**	**1**

***Haplophryne* sp.**	**1**
Melamphaidae	**1**
Melamphaes microps	**21**
***Poromitra* sp.**	**50**
***Scopeloberyx* sp.**	**19**
Scopelogadus beanii	**94**
Rondoletia loricata	**3**
***Gyrinomimus* n.sp.**	**1**
Cetostoma regani	**3**
***Anoplogaster* sp.**	**1**
Anoplogaster cornuta	**17**
Zenopsis conchifer	**1**
Antigonia capros	**9**
Scorpaenidae	**6**
***Peristedion* sp.**	**3**
Howella brodei	**5**
Anthiinae	**17**
Bramidae	**2**
Brama brama	**1**
Pterycombus brama	**1**
Caristiidae	**1**
Lycodes atlanticus	**1**
Lycodes esmarki	**1**
***Chiasmodon* sp.**	**4**
Chiasmodon niger	**5**
Kali indica	**1**
***Pseudoscopelus* sp.**	**1**
Scombrolabrax herterolepis	**1**
Gempylid juvenile	**1**
Diplospinus multistriatus	**1**
Neolotus tripes	**1**
Cubiceps athenae	**2**
***Nomeus* sp.**	**4**
***Psenes* sp.**	**2**
Psenes cyanophrys	**2**
Psenes maculatus	**4**
***Ariomma* sp.**	**3**
Ariomma bondi	**45**
Ariomma melanum	**48**
***Peprilus* sp.**	**1**

Table 3. List of fishes with disjunct distributions at Bear Seamount and the adjacent continental slope. The next nearest known occurrence of these species is at least 1500 km from Bear Seamount.

Hydrolagus pallidus	**E Atl.**
Apristurus microps	**E Atl. or Grand Bank**
Diastobranchus capensis	**S. Africa**
Normichthys operosus	**E Atl. or Grand Bank**
Heterophotus opisthoma	**Florida**
Gigantura indica	**Florida**
Bathypterois dubius	**E Atl. or Grand Bank**
Stemnosudis rothschildi	**Caribbean**
Stylephorus chordata	**Florida**
Brotulotaenia crassa	**Bahamas or Corner Rise**
Bathygadus favosus	**Florida**
Coryphaenoides guentheri	**E Atl.**
Nezumia suilla	**Cuba**
Gaidropsarus argentatus	**Grand Bank**
***Gyrinomimus* n.sp.**	**Caribbean**
Epigonus telescopus	**Corner Rise & E Atl.**
Kali indica	**Gulf of Mexico**

Appendix II. Details of marine mammal methods and results for DE02-06.

Marine mammal survey modes

Because this was a joint survey, marine mammal surveying was conducted under two modes (i.e., primary and secondary). During primary mode (18 - 23; 30-31 July, and 1 August), surveying was conducted along predetermined transect lines. Whereas, during secondary mode (24-29 July) surveying was conducted in association with daytime trawling near Bear Seamount, and "transect lines" were not predefined.

Marine mammal distribution

To determine marine mammal spatial distribution and habitat use, a team of four scientists conducted standard line transect sampling. Track lines covered waters with different characteristics, i.e., depth, temperature, Gulf Stream, and degree of bottom slope topography. During primary sampling the vessel speed was approximately 9-10 knots, whereas, during secondary sampling the vessel speed was approximately 3.5 knots (i.e., fish trawling operations). Surveying in both modes was conducted between 0700-1800 hrs, with an hour off for lunch, and when Beaufort sea state conditions were below five, and visibility exceeded 1 nmi.

The survey team followed standard line transect procedures similar to that described in Palka (1995). The team was located on the flying bridge, 7.9 m above the water line. The scientists rotated through three observation positions where the center person was the recorder and surveyed using the naked eye, while the starboard and port observer searched through 25x150 power binoculars. Every half hour people rotated positions from port to center to starboard to rest to port again.

The starboard observer searched waters on the starboard side and a small overlap area on the port side, that is, from 10° port of the track line to 90° starboard, where 0° is on the track line. The port-side observer searched waters on the port side and a small overlap area on the starboard side, that is, from 10° to starboard of the track line to 90° port. The recorder sat in between the two binocular observers and concentrated searching close to the ship and on the track line, that is, they searched from 30° port to 30° starboard of the track line.

When an animal group (dolphin, whale, or turtle) was detected the following factors were recorded onto a computerized data entry device:

1) time of sighting, recorded to the nearest second,
2) species composition of the group,
3) radial distance between the team's platform and where the sighting was initially detected, estimated either visually when not using the binoculars or by reticles when using binoculars,
4) bearing between the line of sight to the group and the track line; measured by a polarus mounted on the binoculars,
5) best, high and low estimate of group size,

6) initial direction of swim,
7) number of calves,
8) initial sighting cue,
9) initial behavior of the group, and
10) any comments on unusual markings or behavior.

The location (latitude and longitude) of a sighting was determined subsequently using an algorithm which dead reckonings between recorded positions of the ship (see below). Ship's position was recorded every minute.

In addition to the above sighting data, effort data were logged by the recorder, and environmental data were obtained every minute on the ship's fishery scientific computer system (FSCS). Effort data was updated every time one of them changed, and included:

1) time of recording,
2) position of each observer, and
3) weather conditions: swell direction and height, Beaufort sea state, presence of rain or fog, percentage of cloud coverage, visibility (i.e., approximate distance to the horizon), vertical and horizontal position of the sun, and glare width and strength.

Environmental data included:

1) time of recording,
2) latitude and longitude of ship's position,
3) ship's bearing,
4) ship's speed over the ground,
5) wind speed and direction,
6) bottom depth,
7) surface water temperature, and
8) EK500 (18, 38, 120 kHz) acoustic data.

Oceanographic sampling methods

At approximately 1800 hrs, a SEACAT[1] 19 Profiler (CTD) was used to measure temperature, depth, and salinity of the water column in association with plankton sampling using bongo nets. Plankton sampling was conducted using a 505 mesh bongo that was lowered obliquely while traveling at 1.5 to 2.0 knots to 270 m or to within 10 m of the bottom, which ever was shallower. The samples collected by both bongo nets were stored in a jar containing sea water and formalin. Later the species composition and density will be determined and then correlated with marine mammal distribution and trawl catches.

Methods to obtain biopsy samples

Biopsy samples of dolphins were obtained using a 46 kg draw crossbow that shot modified arrows, where the tip of the arrow is actually a corer that retains a 1 mm^2 sample of skin and blubber. Sampling were collected from the bow of the DELAWARE II while the dolphins were bow riding. Once biopsy samples were obtained they were processed as follows: (i) part of the dermis and epidermis into DMSO for genetics; and (ii) remaining skin frozen for stable isotope analysis. Researchers documented the success rate of obtaining the samples, behavior of the animals before and after ever attempted shot, and took photographs.

RESULTS

Relative abundance estimate and spatial distributions

The sighting survey covered approximately 435.68 nautical miles of track line (Figure 1m). Effort also includes the 1 August homebound transect, which approximately, followed the 1000 m isobath. Most of the survey transects (323.0 nmi; 74.2%) were in Beaufort sea state 3 or less (Table 1m).

There were 11 species of identifiable cetaceans seen during the survey: fin, pilot , beaked (Cuvier's, and North Sea), and sperm whales, bottlenose, common, spinner, spotted (2 species), striped, and Risso's dolphins. Leatherback and loggerhead sea turtles were also detected. Number of groups and individuals of each species that were detected are found in Table 2m. Locations of the cetacean sightings are displayed in Figures 2m-3m, and sea turtles in Figure 4m.

Hydrographic Characteristics

Nine CTD casts were made, but four were discarded because they contained "garbage" due to problems with the conducting wire on the hydro-winch. There were three paired CTD and bongo stations at which water temperature, depth and salinity were measured from the surface to within bottom or 270 m, whichever were shallower.

Bongo Samples

There were four bongo stations at which zooplankton samples were collected. At a later time, the species composition and density will be determined and correlated with trawl catches and marine mammal distribution.

Biopsy Samples

Four biopsy tissue samples were collected from three species of dolphins. The species and number of samples were: offshore bottlenose dolphin (1), spotted dolphin (2) and common dolphin (1).

Table 1m. Length (and percentage) of track line surveyed during primary mode in Beaufort sea state conditions 0-5.		
Beaufort sea state	Track line length	% of total
0	0	0
1	11.05	2.54
2	102.66	23.56
3	209.32	48.04
4	105.68	24.26
5	6.97	1.60
total	435.68	100

Table 2m. List of species detected during the R/V DELAWARE II Joint Deepwater Systematics and Marine Mammal Survey, 16 July - 2 August. Included are 1) number of sightings of groups of each species, and 2) best estimates of total number of individual animals seen for each species.

SPECIES Common name	Scientific name	Groups	Individuals
North Sea beaked whale	*Mesoplodon bidens*	5	23
Cuvier's beaked whale	*Ziphius cavirostris*	1	1
unidentified beaked whale	*Mesoplodon* spp.	4	7
Sperm whale	*Physeter macrocephalus*	9	39
Pilot whale	*Globicephala* spp.	13	93
Fin whale	*Balaenoptera acutorostrata*	4	4
Bottlenose dolphin, offsh	*Tursiops truncatus*	14	101
Common dolphin	*Delphinus delphis*	7	1251
Spinner dolphin	*Stenella* spp.	3	28
Spotted dolphin, unid	*Stenella frontalis/ S.*	4	74

	attenuata		
Striped dolphin	*S. coeruleoalba*	3	90
Leatherback turtle	*Dermochelys coriacea*	2	2
Loggerhead turtle	*Caretta caretta*	1	1

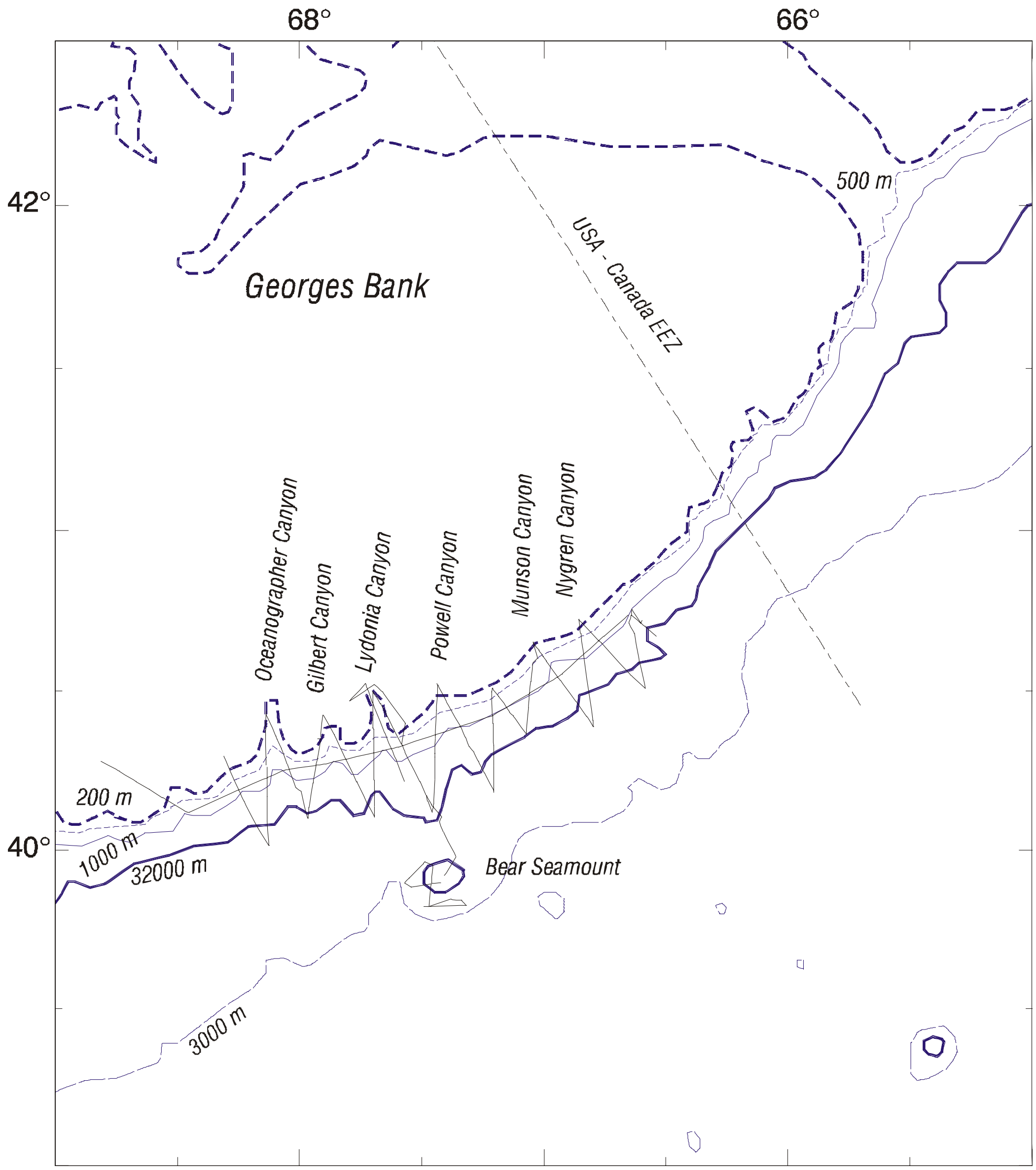

Figure 1m. Track lines surveyed during DE0206 deepwater systematics and marine mammal survey, 16 July - 2 August.

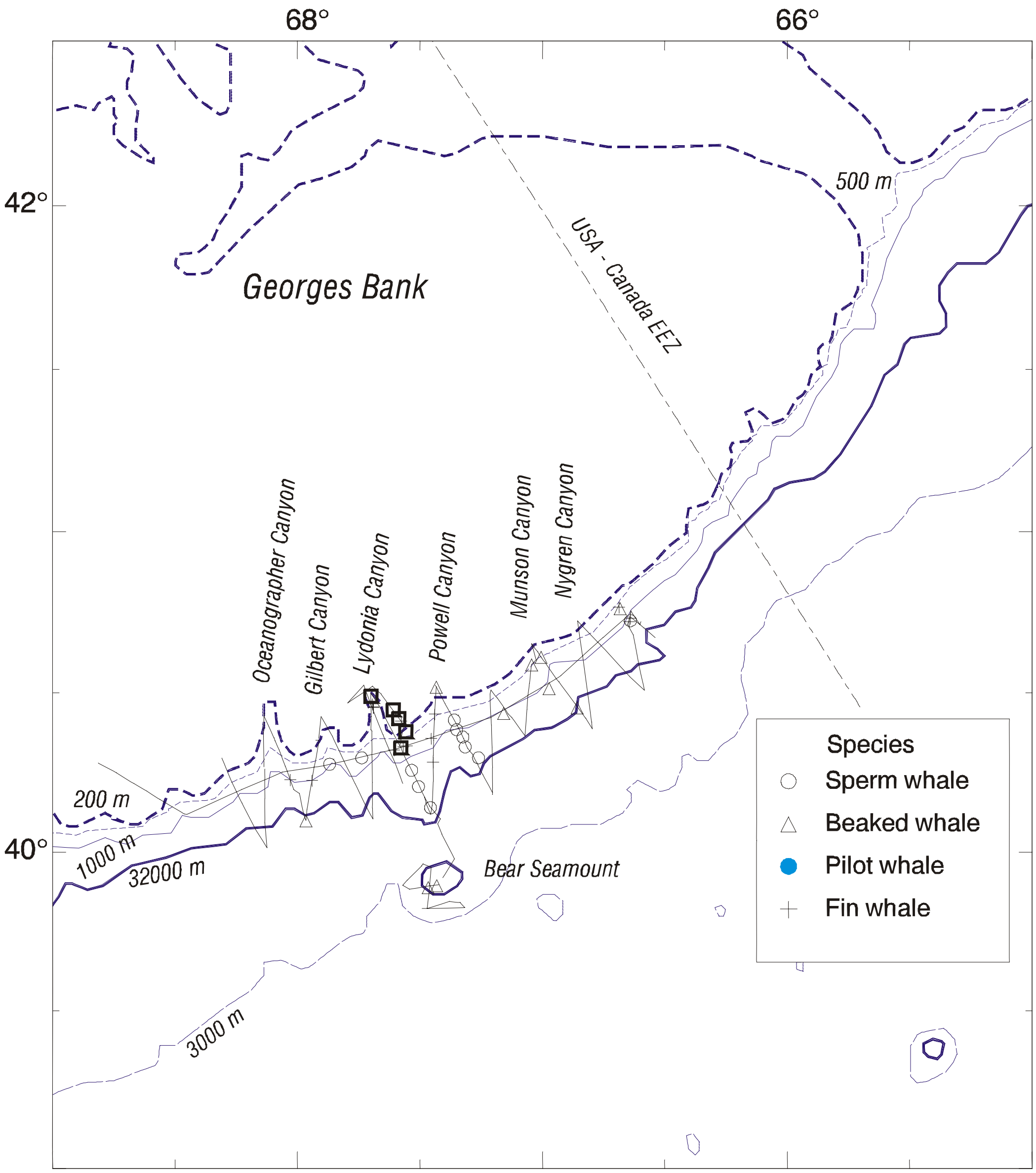

Figure 2m. Sperm whale, beaked whale, pilot whale and fin whale sightings, and track lines lines from deepwater systematics and marine mammal survey , July 2002.

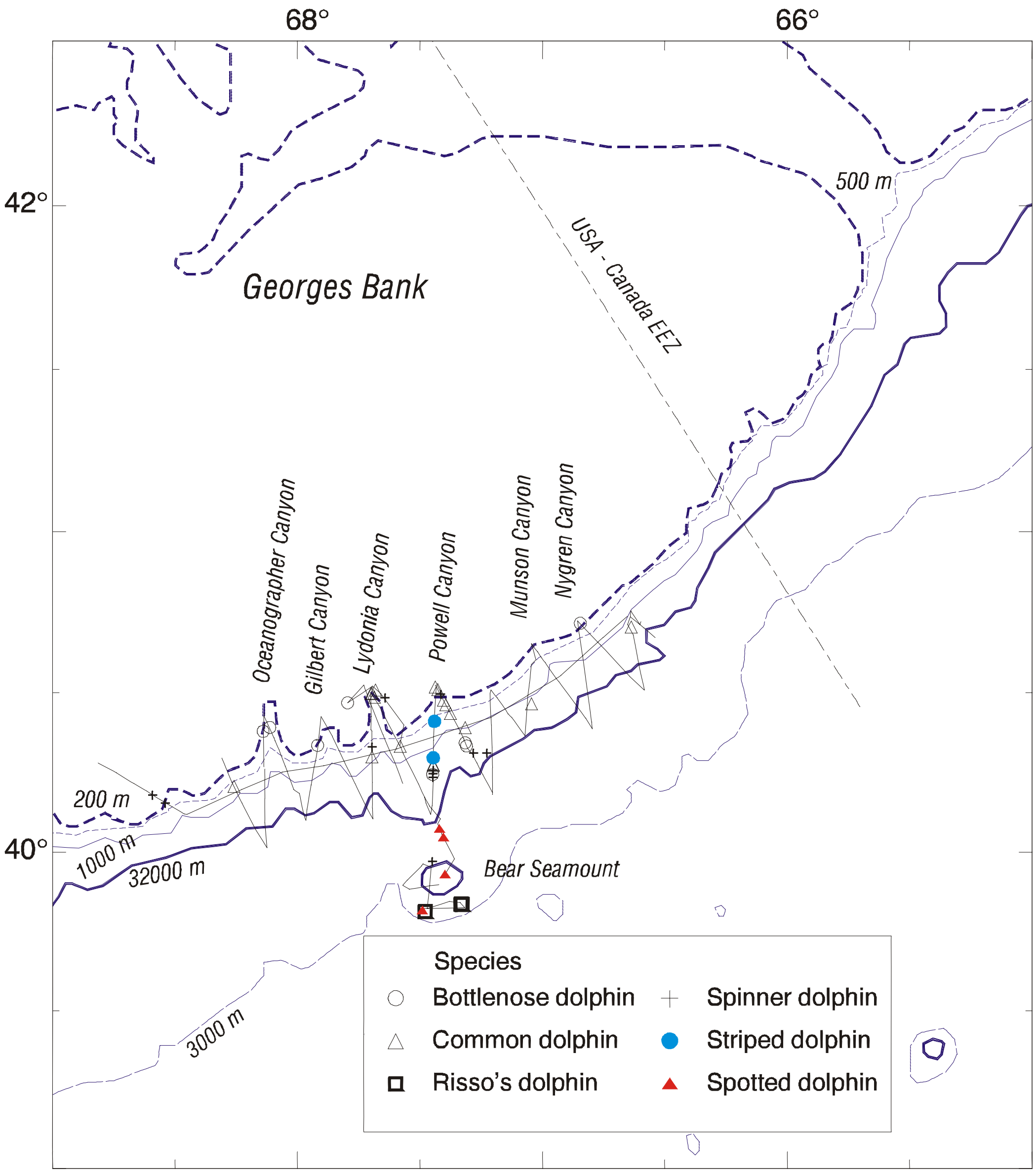

Figure 3m. Pelagic dolphin (bottlenose, common, Risso's, spinner, spotted, and striped) sightings, and track lines from deepwater systematics and marine mammal survey , July 2002.

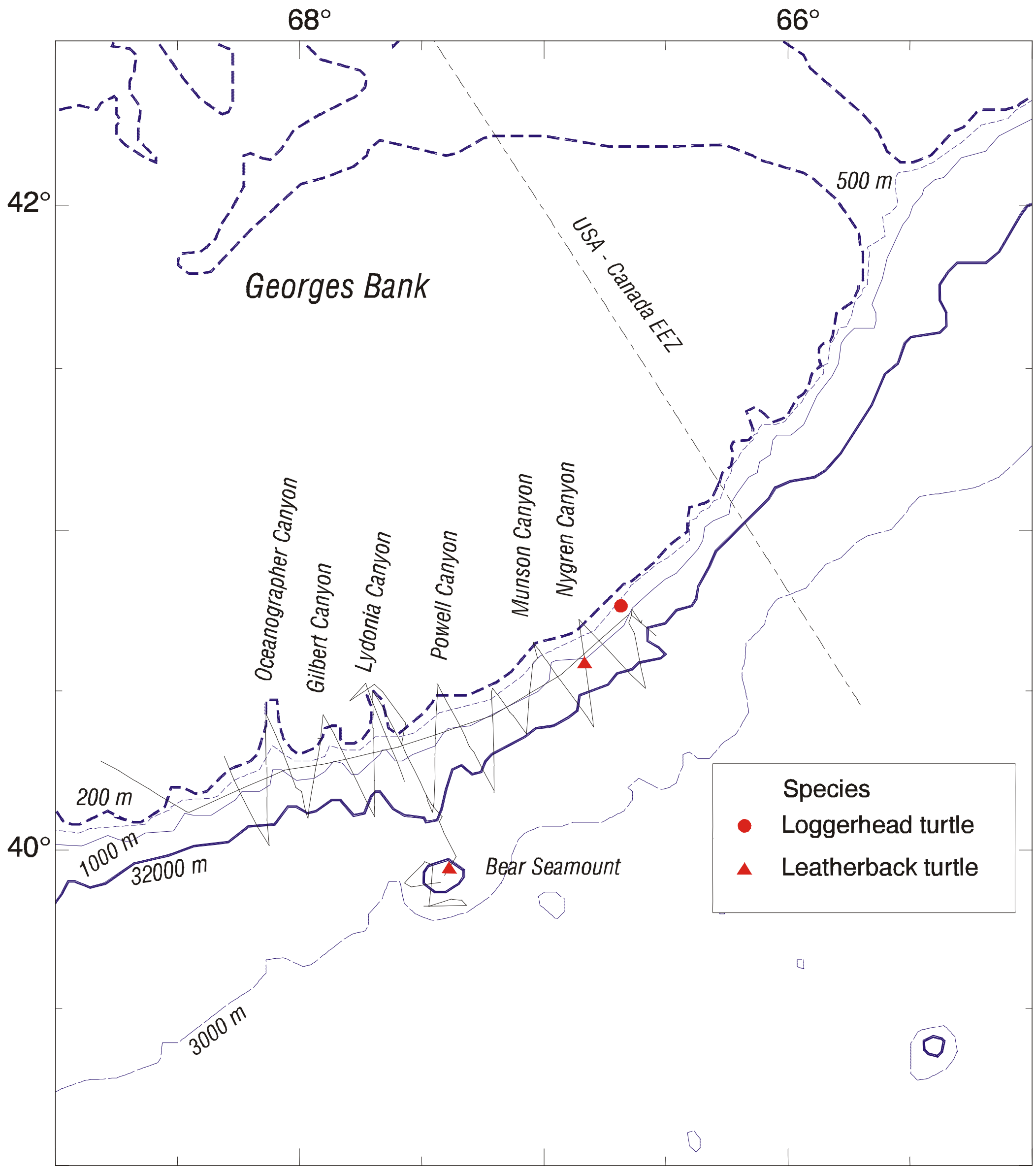

Figure 4m. Loggerhead turtle and leatherback turtle sightings, and track lines from deepwater systematics and marine mammal survey , July 2002.

Appendix III. Physical Oceanography. Contents of ftp site
ftp://ftp.wh.whoi.edu/pub/hydro/del0206/DEL0206_ctd.html

DEEP WATER SYSTEMATICS STUDY
MARINE MAMMAL TRANSECT SURVEY
DEL0206

[seabeam visualization of Bear seamount]

Background

Starting in the winter of 2002 the Oceanography Branch started looking into ways of collecting hydrographic data (i.e. CTD data) on fishing nets. The goal was to find an instrument that could survive a rugged trawling environment and still collect data of good quality. We also wanted the operation to be as "hands-free" as possible so that there would be mimimal interference with the fishing operations. The opportunity to evaluate one instrument came about through the Deep Water Systematics program which was scheduled to work on Bear seamount July 2002. The CTD arrived during the last week of June allowing for roughly 2 weeks of prep time to figure out how we were going to 1) protect it during the trawl 2) Attach it to the trawl and 3) set up the software for data collection and retrieval. The instrument is configured with a sea water switch so that it starts logging data once in the water and shuts off when it is in air (a very nice feature). However, we were a bit disappointed with the size of the "CTD in a Tube" that would require 2 people to attach it to the headrope of the trawl. Also, the dummy plugs that allow the sea-water switch to operate were very difficult to take on and off. Towards the end of the cruise, it became more difficult to establish communication with the CTD and it was also noted that the housing bulkheads were becoming loose.

The battery configuration of this instrument is unsatisfactory because the battery housing is not separate from the electronics and the batteries have to be taped in place. The "CTD in a Tube" was deployed on 32 trawl stations. Data were successfully logged and downloaded from 27 of these hauls and are listed below. The CTD is scheduled to return to the manufacturer for both calibration and possible repairs soon and will be available for the 2003 Deep Water Systematics cruise.

Processing comments

The software provided with the CTD did not have post-processing routines other than simple x-y plotting. I wrote fairly basic MATLAB routines to "bin-average" the raw data to 1 decibar intervals and then make 4 simple figures: 1) the tow profile 2) a T/S plot 3) downcast data 4) upcast data. Salt samples were not taken to monitor any drift in the conductivity cell (this was not possible since it was attached to the trawl) so the data are being made available "as is". Obvious bad data points were removed from the averaged down and upcast files. (Note: a value that was flagged by my routine was replaced with a "NaN" in the output up,down file). I have contacted the manufacturer regarding the problem of not being able to export data that seemed to be in the CTD memory. They believe that there is a software bug and it is possible that more data will be available after they look into the problem. The data for Station 1 came from one of our Seacat CTD's. Operations on the forward work area on board Delaware II were suspended during the cruise due to what appeared to be a failed sea cable termination and /or slip ring corrosion.

Station information:
Table 1. (station listing courtesy of Ruth Gibbons)
DEL0206 CTD Locations: STATIONS.
COASTWATCH IMAGE (routine to plot stations on image courtesy of David Mountain)
NOAA-16 image (from Rutgers "Cool Room")

Marine Mammal Survey figures: (courtesy of Gordon Waring)
Figure 1m: Survey Trackline
Figure 2m: Whale Sightings
Figure 3m: Pelagic Dolphins
Figure 4m: Turtle Sightings
Questions on these figures? Contact Gordon Waring of the Protected Species Branch: gwaring.whsun1.wh.whoi.edu

Station 1
(sea cable termination failed during upcast)
Data (seacat CTD): Down
Figure 1a: Time vs. Pressure, temperature profile
Figure 1b: Temperature/Salinity diagram (downcast only)

Trawl/CTD Stations:

Station 3
Data: Down, Up, Raw
Figure 2a: Time vs. Pressure, temperature profile
Figure 2b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 2c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 2d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 7
Data: Down, Up, Raw
Figure 3a: Time vs. Pressure, temperature profile
Figure 3b: Temperature/Salinity diagram (red = downcast, blue = upcast)

Figure 3c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 3d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 12
Data: Down, Up, Raw
Figure 4a: Time vs. Pressure, temperature profile
Figure 4b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 4c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 4d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 13
Data: Down, Up, Raw
Figure 5a: Time vs. Pressure, temperature profile
Figure 5b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 5c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 5d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 14
Data: Down, Up, Raw
Figure 6a: Time vs. Pressure, temperature profile
Figure 6b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 6c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 6d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 17
Data: Down, Up, Raw
Figure 7a: Time vs. Pressure, temperature profile
Figure 7b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 7c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 7d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 18
Data: Down, Up, Raw
Figure 8a: Time vs. Pressure, temperature profile
Figure 8b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 8c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 8d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 19
Data: Down, Up, Raw
Figure 9a: Time vs. Pressure, temperature profile
Figure 9b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 9c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 9d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 21
Data: Down, Up, Raw
Figure 10a: Time vs. Pressure, temperature profile
Figure 10b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 10c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 10d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 23
Data: Down, Up, Raw
Figure 11a: Time vs. Pressure, temperature profile
Figure 11b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 11c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 11d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 25
Data: Down, Up, Raw
Figure 12a: Time vs. Pressure, temperature profile
Figure 12b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 12c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 12d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 26
Data: Down, Up, Raw
Figure 13a: Time vs. Pressure, temperature profile
Figure 13b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 13c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 13d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 27
Data: Down, Up, Raw
Figure 14a: Time vs. Pressure, temperature profile
Figure 14b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 14c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 14d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 28
Data: Down, Up, Raw
Figure 15a: Time vs. Pressure, temperature profile
Figure 15b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 15c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 15d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 29
Data: Down, Up, Raw
Figure 16a: Time vs. Pressure, temperature profile

Figure 16b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 16c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 16d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 30
Data: Down, Up, Raw
Figure 17a: Time vs. Pressure, temperature profile
Figure 17b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 17c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 17d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 35
Data: Down, Up, Raw
Figure 18a: Time vs. Pressure, temperature profile
Figure 18b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 18c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 18d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 36
Data: Down, Up, Raw
Figure 19a: Time vs. Pressure, temperature profile
Figure 19b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 19c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 19d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 37
Data: Down, Up, Raw
Figure 20a: Time vs. Pressure, temperature profile
Figure 20b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 20c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 20d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 38
Data: Down, Up, Raw
Figure 21a: Time vs. Pressure, temperature profile
Figure 21b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 21c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 21d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 45
Data: Down, Up, Raw
Figure 22a: Time vs. Pressure, temperature profile
Figure 22b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 22c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 22d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 46
Data: Down, Up, Raw
Figure 23a: Time vs. Pressure, temperature profile
Figure 23b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 23c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 23d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 50
Data: Down, Up, Raw
Figure 24a: Time vs. Pressure, temperature profile
Figure 24b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 24c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 24d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 51
Data: Down, Up, Raw
Figure 25a: Time vs. Pressure, temperature profile
Figure 25b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 25c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 25d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 52
Data: Down, Up, Raw
Figure 26a: Time vs. Pressure, temperature profile
Figure 26b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 26c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 26d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 53
Data: Down, Up, Raw
Figure 27a: Time vs. Pressure, temperature profile
Figure 27b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 27c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 27d: Upcast profiles of Temperature/salinity/density (sigma-theta)

Station 54
Data: Down, Up, Raw
Figure 28a: Time vs. Pressure, temperature profile
Figure 28b: Temperature/Salinity diagram (red = downcast, blue = upcast)
Figure 28c: Downcast profiles of Temperature/salinity/density (sigma-theta)
Figure 28d: Upcast profiles of Temperature/salinity/density (sigma-theta)